AUG 0 6 1988

FEMA 480421

FLOOD INSURANCE STUDY

CITY OF JUNCTION, TEXAS
KIMBLE COUNTY

REVISED:

NOVEMBER 4, 1988

Federal Emergency Management Agency

COMMUNITY NUMBER - 480421

NOTICE TO
FLOOD INSURANCE STUDY USERS

This Flood Insurance Study was revised on November 4, 1988. Users should refer to the Revision Description section (Section 9.0) of this text for further information.

Part or all of this Flood Insurance Study may be revised at any time. The user is therefore cautioned that a published map revision (i.e., a revised Flood Insurance Rate Map) may not include a reprinting of the text, tables, and/or profiles, resulting in a discrepancy between the revised map and the original study components. It is the responsibility of the user to consult with community officials to obtain the most current Flood Insurance Study components.

Initial Flood Insurance Study Effective Date: September 28, 1979

Flood Insurance Study Revised: November 4, 1988

TABLE OF CONTENTS

		Page
1.0	INTRODUCTION	1
	1.1 Purpose of Study	1
	1.2 Coordination	1
	1.3 Authority and Acknowledgments	1
2.0	AREA STUDIED	1
	2.1 Scope of Study	1
	2.2 Community Description	3
	2.3 Principal Flood Problems	3
	2.4 Flood Protection Measures	4
3.0	ENGINEERING METHODS	4
	3.1 Hydrologic Analyses	4
	3.2 Hydraulic Analyses	5
4.0	FLOODPLAIN MANAGEMENT APPLICATIONS	6
	4.1 Floodplain Boundaries	6
	4.2 Floodways	6
5.0	INSURANCE APPLICATION	7
	5.1 Reach Determinations	7
	5.2 Flood Hazard Factors	10
	5.3 Flood Insurance Zones	10
	5.4 Flood Insurance Rate Map Description	12

TABLE OF CONTENTS - continued

		Page
6.0	OTHER STUDIES	12
7.0	LOCATION OF DATA	12
8.0	BIBLIOGRAPHY AND REFERENCES	12
9.0	REVISION DESCRIPTION	13
9.1	Purpose	13
9.2	Acknowledgments	13
9.3	Scope	13
9.4	Hydrologic and Hydraulic Analyses	13
9.5	Floodways	13

FIGURES

Figure 1 - Vicinity Map 2

Figure 2 - Floodway Schematic 9

TABLES

Table 1 - Summary of Discharges 5

Table 2 - Floodway Data 8

Table 3 - Flood Insurance Zone Data 11

EXHIBITS

Exhibit 1 - Flood Profiles

Llano River	Panel 01P
North Llano River	Panels 02P-03P
South Llano River	Panel 04P

Exhibit 2 - Flood Boundary and Floodway Map

PUBLISHED SEPARATELY:

Flood Insurance Rate Map

FLOOD INSURANCE STUDY
CITY OF JUNCTION, KIMBLE COUNTY, TEXAS

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the City of Junction, Kimble County, Texas, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of the information will be to convert the City of Junction to the regular program of flood insurance by the Federal Insurance Administration (FIA). Further use of the information will be made by local and regional planners in their efforts to promote sound land use and floodplain development.

1.2 Coordination

The identification of streams requiring study was accomplished in meetings attended by personnel of Turner Collie & Braden, the FIA, and officials of the City of Junction in March 1976.

During the course of the work by Turner Collie & Braden, flood elevations, flood boundaries, and floodway delineations were reviewed with community officials. On September 18, 1978, the results of the work by Turnie Collie & Braden were reviewed at a final coordination meeting attended by personnel of Turner Collie & Braden, the FIA, and the City of Junction.

1.3 Authority and Acknowledgments

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were performed by Turner Collie & Braden for the Federal Insurance Administration under Contract No. H-3973. This work, which was completed in January 1978, covered all significant flooding sources in the City of Junction.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorpoated area of the City of Junction. The area of study is shown on the Vicinity Map (Figure 1).

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF JUNCTION, TX
(KIMBLE CO)

APPROXIMATE SCALE

4 0 4 8 12 MILES

VICINITY MAP

Floods caused by overflow of the Llano River, North Llano River, and the South Llano River were studied in detail. Stream reaches selected for detailed study are those with substantial existing floodplain development or with significant future development expected to occur before 1982.

Flood hazard determinations were based on conditions expected to exist 12 months following completion of the review draft of the Flood Insurance Study. No significant change in flood hazards is expected to occur during this 12-month period.

2.2 Community Description

Junction is located in central Kimble County, 121 miles northeast of San Antonio in the Hill Country of south-central Texas. The population of Junction is 2,654 (1970 census), compared to a county population of 3,904 (1970 census). The economy of the area is based primarily on ranching and tourism.

The study area is in the Edwards Plateau goelogic region. Topography within the area ranges from gently sloping areas adjacent to natural watercourses to rolling hills along drainage divides.

Predominant topsoils are gray to brown sandy loams, which are underlain by beds of limestone and interbedded limestone and marls. Native vegetation is comprised predominantly of mid-grasses intermixed with live oak, savanna, juniper, and some mesquite. The climate is semi-arid with average annual precipitation of 22 inches.

The North Llano and South Llano Rivers flow west to east through Kimble County, and join together near the eastern corporate limits of Junction. At Junction, the North Llano River flows along the northern corporate limits and the South Llano River flows along the southern and eastern corporate limits. Scattered residential development exists within the floodplains of these three streams.

2.3 Principal Flood Problems

Low-lying areas of Junction are subject to periodic flooding by overflows of the Llano River, North Llano River, and South Llano River. The flood of record of the Llano and South Llano Rivers occurred in June 1935. The 1935 flood produced peak discharges at Junction of 319,000 cubic feet per second (cfs) on the Llano River (U. S. Geological Survey (USGS) estimate) and 254,000 cfs on the South Llano River (U. S. Army Corps of Engineers (COE) estimate). The 1935 flood is the largest known to have occurred on the Llano and South Llano Rivers since 1875. The recurrence interval of this event is estimated to be about 80 years for the Llano River and 150 years for the South Llano River. The flood of record on the North Llano River occurred in September 1936. The 1936 flood produced a peak discharge on the North Llano River at Junction of 94,800 cfs

(USGS) estimate) and reached an elevation at U. S. Route 290 bridge of 1,705.5 feet National Geodetic Vertical Datum of 1929 (NGVD). This flood is the largest known to have occurred since at least 1875. The recurrence interval of this event is estimated to be about 19 years.

2.4 Flood Protection Measures

No flood protection measures have been undertaken within Junction.

3.0 ENGINEERING METHODS

For flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10-, 50-, 100-, and 500-years have been selected as having special significance for floodplain management and for flood insurance premium rates. The analyses reported here reflect current conditions in the drainage areas of the streams.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Peak discharges of the Llano River and the North Llano River were estimated by frequency analyses of flood flow records at USGS streamflow gaging stations. The gaging station on the Llano River is located 3.8 miles downstream from the confluence of the North Llano and South Llano Rivers. The gaging station on the North Llano River is located about 4 miles upstream from its confluence with the South Llano River. Flood flow records dating to 1915, when both stations were established in the vicinity of the present gage locations, are available for frequency analysis. Historic flood information dating to 1875 is also available. Flood flow frequency curves were computed from these flood data following recommended procedures of the U. S. Water Resources Council (Reference 1). The frequency curve developed for North Llano River flood flows was used to estimate South Llano River flood flows, since the drainage areas of these two rivers are approximately equal in size and shape and have similar geologic and hydrologic characteristics.

The peak discharge-drainage area relationships for the selected recurrence intervals are presented in Table 1, "Summary of Discharges."

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
LLANO RIVER					
USGS gage	1,874	84,200	258,000	375,000	781,000
NORTH LLANO RIVER					
USGS Gage	914	63,400	170,000	231,000	409,000
SOUTH LLANO RIVER					
At mouth	935	63,400	170,000	231,000	409,000

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

Water-surface elevations for the 10-, 50-, 100-, and 500-year floods were computed using a computer program developed by the COE, Hydrologic Engineering Center (Reference 2).

Channel and valley cross sections of streams studied in detail were obtained by field surveys. Additional cross sections were obtained from the COE and the U. S. Soil Conservation Service. Cross sections at several bridges were obtained from the Texas State Department of Highways and Public Transportation. Average spacing of cross sections utilized in hydraulic computations is 1,600 feet. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Roughness values (Manning's "n") were estimated for stream channels and floodplain areas on the basis of field inspection, COE estimates, and aerial photographs. Selected roughness values were verified by reproduction of flood elevations recorded for the June 1935 flood of the Llano River and South Llano River, and the September 1936 flood of the North Llano River. A channel roughness value of 0.045 was used for all three streams. Overbank roughness values ranged from 0.05 to 0.11.

Starting water-surface elevations for Llano River flood profiles were determined from normal depth computations. Starting water-surface elevations for North Llano River and South Llano River flood profiles were based on Llano River water-surface elevations for flood flows of corresponding frequencies.

The hydraulic analyses are based on existing conditions. Calculated flood elevations are valid only if the waterway structure and channel and overbank characteristics remain in essentially the same conditions as ascertained for the time period covered under the scope of this study.

Flood profiles were drawn showing the computed water-surface elevations for floods having the selected recurrence intervals of 10-, 50-, 100-, and 500-years (Exhibit 1). These profiles are considered to have an accuracy of 0.5 foot. All elevations used in this study are measured from NGVD. Elevation reference marks used in this study are shown and described on the maps.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound floodplain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of floodplain management measures. The 500-year flood is used to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100-year and the 500-year floods have been delineated using the flood elevations at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:12,000 with a contour interval of 20 feet (Reference 3). In cases where the 100-year and the 500-year boundaries are close together, only the 100-year boundary has been shown. The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 2). Small areas within the flood boundaries may lie above the flood elevations and, therefore, not be subject to flooding; owing to limitations of the map scale, such areas are not shown.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the National Flood Insurance Program, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 100-year floodplain is divided into a floodway and a floodway

fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights. Minimum federal standards limit such increases to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as a minimum standard that can be adopted directly or that can be used as a basis for additional floodway studies.

To avoid hazard flow velocities in encroached floodplain areas, encroachment on the floodplains was limited to areas with flow velocities, during occurrence of the 100-year flood, of less than about three feet per second. Floodways based on this criterion are shown for the Llano River, North Llano River, and South Llano River. The results of floodway determinations are tabulated for selected cross sections in Table 2.

As shown on the Flood Boundary and Floodway Map (Exhibit 2), the floodway boundaries were computed at cross sections. Between cross sections, the boundaries were interpolated.

The area between the floodway and 100-year floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood by more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 2.

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source studied in detail affecting the City of Junction.

5.1 Reach Determinations

Reaches are defined as sections of floodplain that have relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference may not have a variation greater than that indicated in the following tabulation for more than 20 percent of the reach:

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Llano River							
A	110.39	1530/280[2]	37,063	10.1	1701.0	1700.5	0.5
B	110.58	1940/150[2]	51,245	7.3	1703.2	1702.7	0.5
North Llano River							
A	.88	2514/1365[2]	41,745	5.0	1706.4	1705.5	0.9
B	1.24	2037/300[2]	26,989	7.9	1708.5	1707.6	0.9
South Llano River							
A	0.24	1342/520[2]	33,483	6.9	1705.3	1704.3	1.0
B	0.45	1342	31,239	7.4	1706.5	1705.6	0.9
C	0.93	2840/2030[2]	58,883	3.9	1708.7	1708.0	0.7
D	1.29	2563/1870[2]	41,797	5.5	1709.5	1708.9	0.6
E	1.55	1834/1230[2]	36,250	6.4	1710.8	1710.0	0.8
F	1.93	1800/300[2]	30,196	7.7	1714.1	1713.3	0.8

[1]Miles above mouth.
[2]Total width/width within corporate limits.

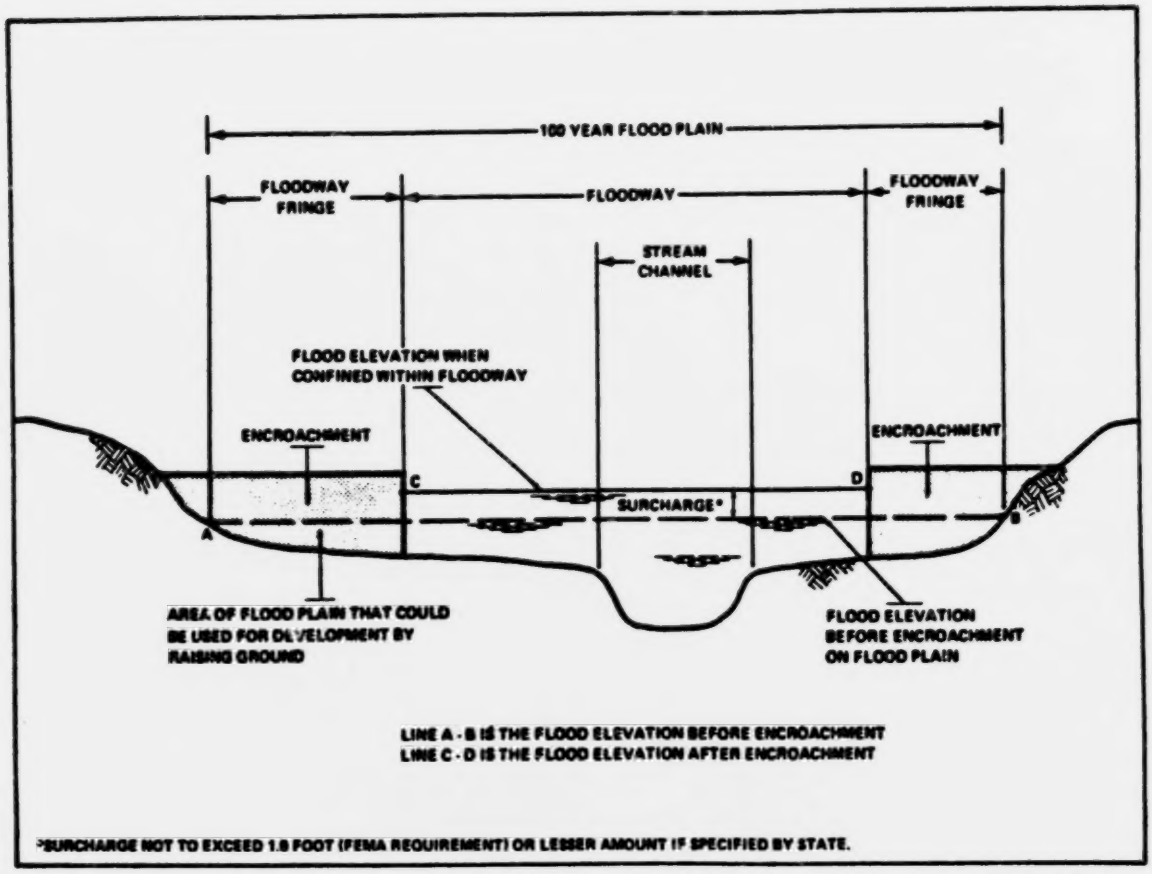
TABLE 2

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF JUNCTION, TX
(KIMBLE CO.)

FLOODWAY DATA

LLANO RIVER - NORTH LLANO RIVER - SOUTH LLANO RIVER


100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
SURCHARGE*
A
B
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FEMA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC Figure 2

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot
7.1 to 12 feet	2.0 feet
More than 12 feet	3.0 feet

Three reaches meeting the above criteria were required for the flooding sources in the City of Junction. These include one each for the three flooding sources studied in detail. The locations of the reaches are shown on the Flood Profiles (Exhibit 1).

5.2 Flood Hazard Factors

The Flood Hazard Factor (FHF) is used to establish relationships between depth and frequency of flooding in any reach. This relationship is then used with depth-damage relationships for various classes of structures to establish actuarial insurance rate tables.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations rounded to the nearest one- half foot, multiplied by 10, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, it is rounded to the nearest whole foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the City of Junction was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zones A24,A27:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown, and zones subdivided according to FHFs.
Zone B:	Areas between the Special Flood Hazard Areas and the limits of the 500-year flood; areas that are protected from the 100- or 500-year floods by dike, levee, or other water control structure; areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding; not subdivided.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for each flooding source studied in detail in the community.

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND			FHF	ZONE	BASE FLOOD ELEVATION[3] (NGVD)
		10% (10 YR.)	2% (50 YR.)	0.2% (500 YR.)			
Llano River Reach 1	0005	-17.4	-5.4	9.5	170	A27	Varies
North Llano River Reach 1	0005	-14.3	-3.8	6.1	140	A24	Varies
South Llano River Reach 1	0005	-14.3	-4.8	10.3	140	A24	Varies

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO NEAREST FOOT – SEE MAP

TABLE 3

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
Federal Insurance Administration

CITY OF JUNCTION, TX
(KIMBLE CO.)

FLOOD INSURANCE ZONE DATA

LLANO RIVER – NORTH LLANO RIVER – SOUTH LLANO RIVER

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the City of Junction is, for insurance purposes, the principal result of the Flood Insurance Study. This map contains the official delineation of flood insurance zones and base flood elevations. Base flood elevation lines show the locations of the expected whole-foot water-surface elevation of the base (100-year) flood. The base flood elevations and zone numbers are used by insurance agents, in conjunction with structure elevations and characteristics, to assign actuarial insurance rates to structures and contents insured under the National Flood Insurance Program.

6.0 OTHER STUDIES

No other detailed studies have been made prior to this study. This present study is therefore authoritative for the purposes of the Flood Insurance Program.

7.0 LOCATION OF DATA

Information concerning the pertinent data used in preparation of this study can be obtained by contacting FEMA, the Natural and Technological Hazards Division, Federal Regional Center, 800 North Loop 288, Denton, Texas 76201-3698.

8.0 BIBLIOGRAPHY AND REFERENCES

1. U. S. Water Resources Council, Hydrology Committee, "Guidelines for Determining Flood Flow Frequency," Bulletin 17, Washington, D. C., March 1976.

2. U. S. Army Corps of Engineers, "Water-Surface Profiles," Generalized Computer Program 723-02A, The Hydrologic Engineering Center, October 1973.

3. U. S. Geological Survey, Quadrangle Maps, 7.5-Minute Series, 1970 Issue: Big Draw, Elm Slough, Segovia N.W., Junction N.E., Texas.

U. S. Army Corps of Engineers, "Flood Hydrograph Package," Generalized Computer Program 723-010, The Hydrologic Engineering Center, January 1973.

TEXT REVISIONS
CITY OF JUNCTION, KIMBLE COUNTY, TEXAS

9.0 REVISION DESCRIPTION

9.1 Purpose

The purpose of this revision is to incorporate new and/or revised data into the currently effective Flood Insurance Study for the City of Junction, Kimble County, Texas. This revision is intended to provide updated information that aids in the National Flood Insurance Act of 1968 and the Flood Insurance Disaster Protection Act of 1973.

9.2 Acknowledgments

The hydrologic and hydraulic data for this revision were prepared by Turner Collie & Braden (the study contractor) for the original Flood Insurance Study. The Federal Emergency Management Agency (FEMA) reviewed and accepted these data for purposes of this revision.

9.3 Scope

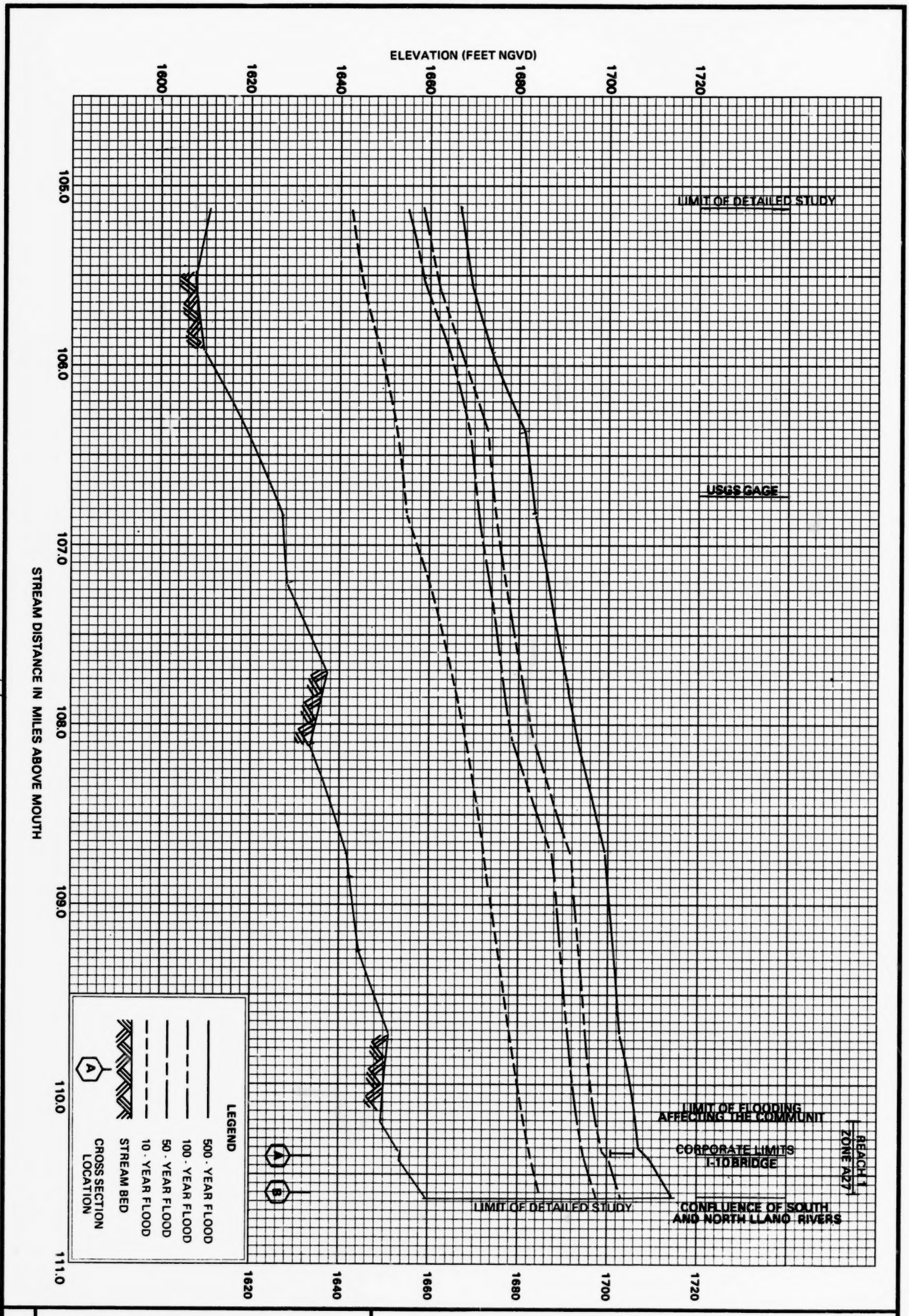
This revision reflects changes to the North Llano River based on a recent land annexation to the community. The Flood Insurance Rate Map (FIRM) and the Flood Boundary and Floodway Map (FBFM) panels were revised to include extension of detailed hydraulic data into the annexed area.

9.4 Hydrologic and Hydraulic Analyses

The detailed analyses for the North Llano River were obtained from topographic data supplied by the study contractor, and was used to delineate the 100- and 500-year floodplain boundaries through the newly annexed areas.

9.5 Floodways

The additional floodway delineated along the North Llano River was based on existing analyses from the original study contractor.



FEDERAL EMERGENCY MANAGEMENT AGENCY

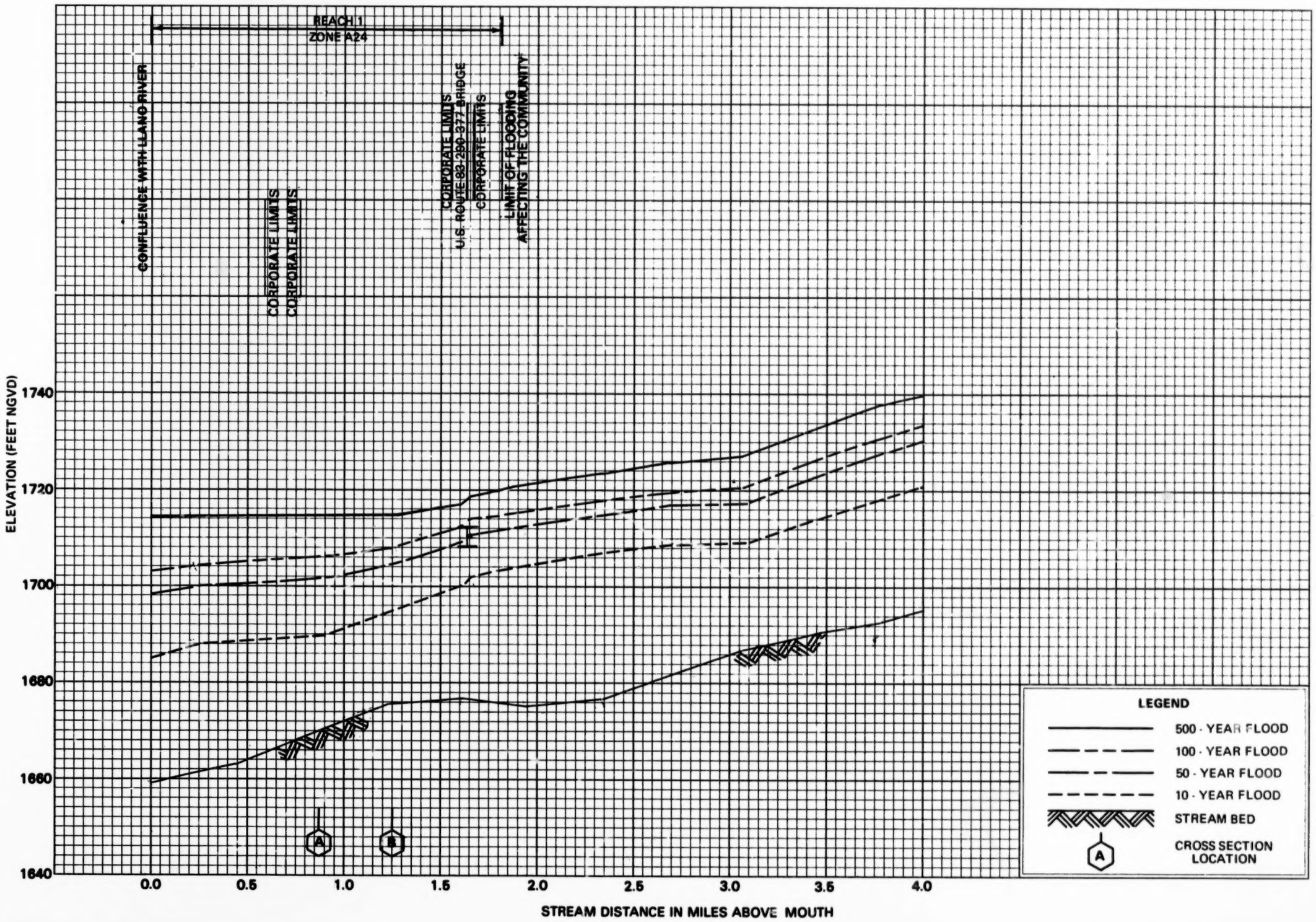
CITY OF JUNCTION, TX

(KIMBLE CO.)

FLOOD PROFILES

LLANO RIVER

01P



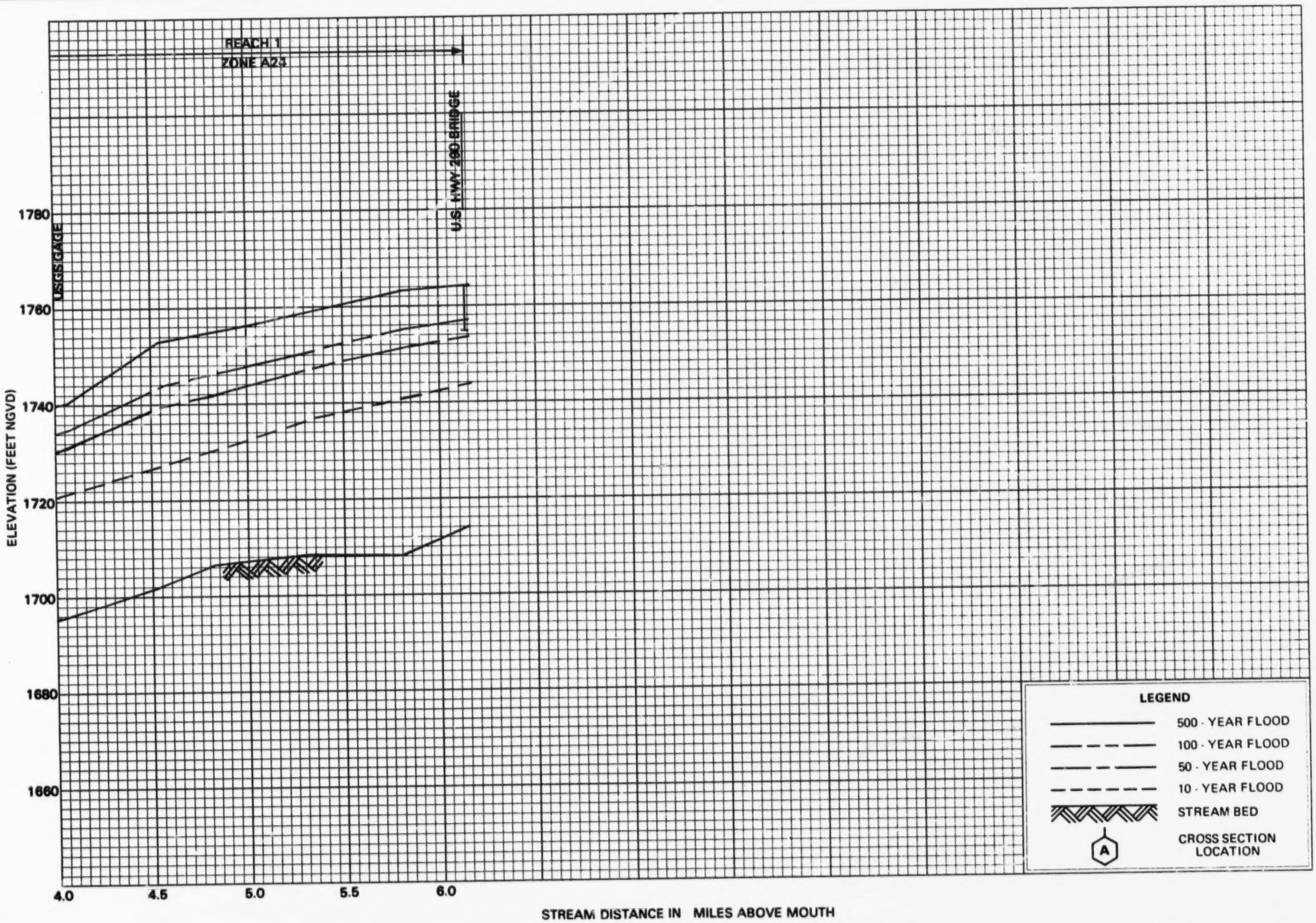
FLOOD PROFILES

NORTH LLANO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF JUNCTION, TX
(KIMBLE CO.)

02P



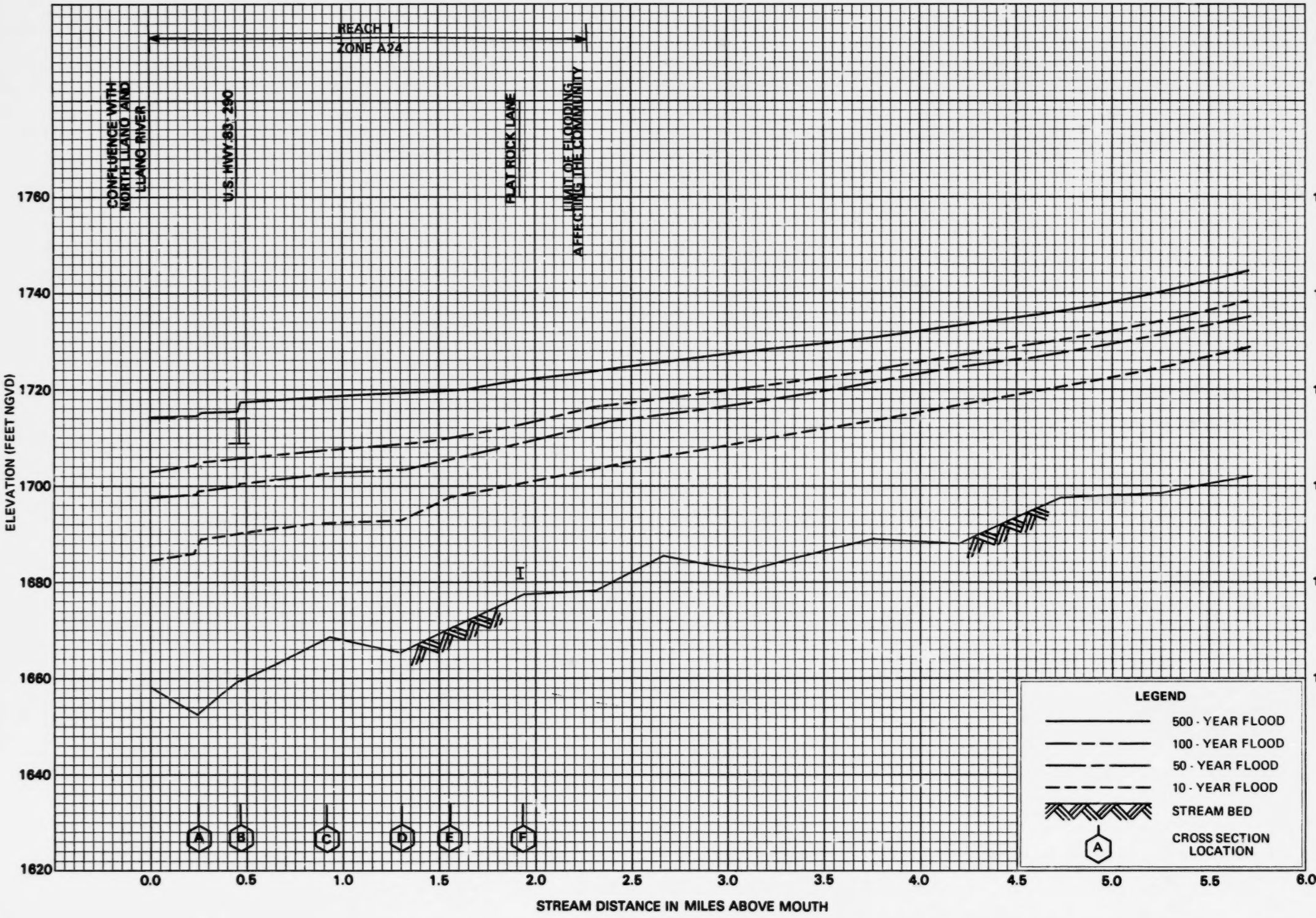
FLOOD PROFILES

NORTH LLANO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF JUNCTION, TX
(KIMBLE CO.)

03P



FLOOD PROFILES

SOUTH LLANO RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF JUNCTION, TX
(KIMBLE CO.)

04P